CONCEPTUAL FEASIBILITY STUDY FOR CENTRALIZED TREATMENT OF PETROLEUM CONTAMINATED SOIL

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for

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Trenton, New Jersey 08625

by

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16. Abstract

This study was conducted to determine the feasibility of a permanent or semi- permanent soil treatment facility for petroleum contaminated soil generated by the New Jersey Department of Transportation (NJDOT) five year highway improvement plan and underground storage tank (UST) upgrade and replacement project. Early in the project it was determined that the New Jersey General Services Administration (NJGSA) had a need to dispose of soil from USTs and that it would benefit both NJDOT and NJGSA to work together on the problem. The amount of soil generated by highway projects will be small in comparison to the amount generated by the USTs. There is an estimated 1300+ UST's that need to be removed between NJDOT and NJGSA, half are estimated to be leaking. This will generate about 130,000 cubic yards (cy) in addition to 40,000 cy generated from road improvement projects. This means that approximately 34,000 cy/year will needed to be treated over the next five years. After reviewing all available data and visiting a number of NJDOT and NJGSA sites, three options were considered for treatment of the soil: A mobile low temperature thermal desorption (LTTD)unit, a centralized LTTD unit including soil recycling facilities, and a centralized biological land treatment facility. To facilitate a cost effective application of centralized treatment facilities, the distribution of anticipated contaminated soil and available space was considered, the state was then divided into two parts. Due to the shortage of public land in the northern part of the state and the relatively small amount of soil to be generated per year, an established soil recycling facility is being recommended. In the southern part of the state, we are recommending the use of state prison land for biological land treatment and possibly using properly trained inmates to cultivate the soil in order to decrease costs.

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SUMMARY & CONCLUSIONS

The following are conclusions based upon research done by the New Jersey Institute of Technology (NJIT) and data provided:

1. Petroleum contaminated soil derived from the remediation of Underground Storage Tanks (USTs) and highway construction projects is estimated to be 170,000 cy over a five year period This estimate is based upon 200cy/UST for the aforementioned projects of the New Jersey Department of Transportation (NJDOT) and New Jersey General Service Administration (NJGSA).

2. The estimated amount of petroleum contaminated soil generated by only NJDOT's USTs and highway construction projects do not warrant a centralized land treatment facility or Low Temperature Thermal Desoption (LTTD) mobile unit.

3. Land treatment and/or LTTD appear to be conceptually feasible, based upon cost for the treatment of petroleum contaminated soil resulting primarily from the UST program of both the NJDOT and NJGSA. Space required for a land treatment facility including a suitable buffer is estimated at 120 acres while space for a LTTD is estimated at ¼ acre.

4. To facilitate a cost-effective application of centralized facilities, the distribution of contaminated soil and available space was considered. The state was then divided into two parts.

5. There are sites that are potentially suitable for a permanent or semi permanent treatment facility.

RECOMMENDATIONS

1. Due to the shortage of space in the northern part of the state and the central location of a soil recycling facility (Mt. Hope Rock Products), soil generated in the northern half of the state can be cost effectively processed at the Mt. Hope Recycling facility.

2. In the southern part of the state NJGSA land can be used to process soil through land treatment. The Albert Wagner Facility in Bordentown is recommended as the first location to be further evaluated. As stated later in this report, we are not recommending the use of the Walter R. Earle recycling facility as the primary source of processing soil through land treatment due to its location in the Pine Barrens. However, this facility may be used for contaminated soils produced within the Pine Barrens.

3. NJDOT and NJGSA should work together to further evaluate the feasibility of locating a land treatment facility on NJGSA property such as the Albert Wagner facility.

INTRODUCTION

Objective

This study will investigate the conceptual feasibility of permanent biological land treatment or low temperature thermal desorption (LTTD) facilities for the treatment of petroleum contaminated soil for NJDOT highway construction projects.

Background

A study conducted by the New Jersey Institute of Technology (NJIT) for NJDOT on alternatives to the disposal of contaminated soil (reference the NJIT report entitled "Alternatives to the Disposal of Contaminated Soil", April 1994) identified two potentially viable technologies that can be implemented as a centralized facility; biological land treatment and LTTD. This project builds on this earlier study. Its main objective is to investigate the conceptual feasibility of implementing a centralized (permanent or semi-permanent) facility for treatment of petroleum contaminated soil using biological land treatment and LTTD. Specifically, the study was designed to determine whether a centralized treatment facility can cost-effectively meet the environmental needs of future NJDOT planned construction. It was intended that the results will assist NJDOT in making a planning decision to evaluate the concept in greater detail.

State-of-the-Art Technology Description

Biological Land Treatment

Biological land treatment is a process by which contaminated soils are excavated from the source location and treated in a prepared surface bed. The soil is spread over a large area to a relatively shallow depth (6 to 18 inches). The treatment and removal mechanisms at work in land treatment include a combination of volatilization, biodegradation, and photolysis. Frequent tilling and/or mixing to aerate the soil, and the addition of nutrients, moisture, or agents to control pH is usually applied to optimize treatment. Also, if there is a deficiency of acclimated native microorganisms in the soil, then microbial inoculum is added. The soil generally will need to be in place for 3 to 9 months depending on the concentrations of the contaminants.

Land treatment is a commercially available technology which has been demonstrated extensively for treatment of petroleum contaminated soils (see **Figure 1**, page 10). It has proven to be the lowest cost treatment method for petroleum contaminated soils.

Low Temperature Thermal Desorption (LTTD)

The LTTD process is a technology which removes the Total Petroleum Hydrocarbons (TPHC) from the soil matrix for subsequent treatment. Its primary advantage is that the removal of the contaminant from the soil can be accomplished without having to heat the soil to its combustion temperature. This results in significant energy savings, and does not cause significant thermal modification of the soil structure. This treatment process is not applicable for metal contaminated soil.

In the process, soil is conveyor fed into a thermal processor which desorbs the contaminants at temperatures typically less than 1000°F. TPHC contaminated soil can be treated at temperatures less than 600°F. Handling mechanisms in the thermal processor vary among vendors. The vapor stream from the thermal processor is passed through a gas cleaning train, which consists of both a filter system to remove particulate, and through an afterburner which combusts the VOC gases, followed by scrubbing of the exhaust gases. The processed soil once cooled and moistened is then ready for reuse. Another variation of this technology utilizes the same desorption system, but separates and condenses the organic contaminants for non combustive treatment. (**Figure 2** page 11) shows a LTTD configuration.

LTTD is a commercially available technology, which has been demonstrated for treating soils containing TPHC and other VOC's such as chlorinated hydrocarbons. It is capable of treating any soil matrix including silt and clay. The mobilization cost for on-site treatment using this technology is relatively high, so its best applications would be for large projects, or possibly for use in a central processing yard. For treatment quantities less than 2000 cubic yards cy, other alternatives or off-site disposal is more economical. Another option is to consider a centralized soil recycling facility that would be able to handle the volume of soil generated from tank pulls and road reconstruction projects. In utilizing an established recycling facility quantities as small as 25 yards could be treated at a reasonable price. For example, a facility such as Mt. Hope Recycling, located in Rockaway, NJ, is capable of handling loads as large as 1000 cy per day. Mt. Hope is also New Jersey Department of Environmental Protection (NJDEP) certified to test samples from a list of metals, VOC's and PCB'S.

Description of Project Locale

NJDOT has 237 tanks in their facility based inventory of which 85 are considered for priority attention. A breakdown of these tanks by region is provided below. (**Figure 3** page 12) shows the locations by county where the contaminated soil will be generated.

Region	Total USTs	Priority USTs
North Region	78	40
Central Region	90	19
South Region	69	26
	237	85

The CY of contaminated soil that can be generated by the program to remove, replace or upgrade the NJDOT UST inventory will be site specific and related to the circumstances affecting underground tank leaks. Factors generally considered important include: type and size of tank; age of tank; soil characteristics; groundwater level; and design or operational conditions including spills, improper installation or ineffective leak detection program. Also, the cleanup standards established by the NJDEP will dictate the extent of soil removal necessary. Several sources of information as discuss later were used to estimate the CY of contaminated soil that can be expected to be generated by an UST action.

STUDY PROCEDURES

The project as outlined in the proposal was conducted as follows:

Task 1:Estimate the quantity and potential concentration of petroleum contaminated soil - based upon a one year and five year highway construction planning cycle. A statewide map by NJDOT Regions will be prepared to depict the projected distribution of contaminated soil potentially requiring treatment.

Task 2:Identification of potential NJDOT facilities that may be suitable for a centralized facility - Using site selection criteria including: 1) location of highway projects anticipated to generate petroleum contaminated soil; 2) adequate space; 3) suitable environmental consideration; 4) access; 5) available utilities; 6) anticipated regulatory and community acceptance, and 7) potential reuse. A maximum of three potential sites will be identified for site visit and evaluation. Other non-NJDOT facilities will also be considered.

Task 3:Development of conceptual design - including treatment system throughput, environmental protection requirements, regulatory requirements and operation optimization. The conceptual design should include a site plan.

Task 4:Develop cost - rough order of magnitude (ROM) cost will be calculated based upon the facility conceptual design. A comparison of project specific treatment approaches will be made taking into account transportation, regulatory compliance, mobilization/ demobilization, etc.

Early in the data-gathering phase of this project, it became apparent that the treatment needs identified through the New Jersey General Services Administration (NJGSA) program for state-owned USTs were considered beneficial to the project. This is, in part, due to the potential for scale-up economics (i.e., the larger the quantities of soil to be treated, the less expensive the costs and vice versa) and for properties managed by NJGSA as potentially viable treatment sites. It was, therefore, decided that the scope of the study be modified to include the needs of NJGSA.

This report provides the results of study carried out under this project. Several meetings were held with representatives from NJDOT, NJDEP and NJGSA to assist the team in its efforts.

RESULTS AND DISCUSSION

- Task 1: Estimate Contaminated Soil

Based upon available information regarding projects included in the one and five-year road improvement program it should not be expected that sufficient quantities of contaminated soil will be generated to cost- effectively support a centralized facility. However, a recently initiated NJDOT program to replace, upgrade and remediate USTs in compliance with state regulations has become a particular concern since it is expected that this program will generate petroleum contaminated soil that will require treatment. An analysis of this ongoing program indicates that 40,000 cubic yards (CY) of contaminated soil will need proper treatment over the next five years (a small amount of this material is assumed to come from highway improvement projects). This estimate was derived using available information on the number of NJDOT USTs requiring attention (see Description of Project Locale for the number and location of NJDOT USTs) and several sources of information regarding the amount of contaminated soil (CY) anticipated for an UST project.

- NJDEP has used for bidding documentation purposes of 72 CY/UST.
- NJDOT contract for UST activities includes an estimate of 200 CY/UST.
- A document prepared by the US EPA, ("Cleaning Up the Nation's Waste Sites - Markets and Technology Trends," April 1993) reported that a 1990 EPA study which provided data from 16 states indicated that the range of contaminated material for UST action was 9 to 800 CY with a weighted average of 190 CY.

Using the above, it would appear that the most represented estimate for UST-generated contaminated soil is the EPA weighted average of 190 CY. Therefore, this study will use a gross estimate of 200 CY/UST action. NJIT, based upon this unit figure, would estimate that the NJDOT will generate approximately 40,000 CY of contaminated soil that will probably need to be treated over the next five years. About 23,000 CY will come from facility UST remediation (assuming 50% of the existing UST are found to be leaking) with the remainder from highway improvement projects which may involve contaminated soil and/or UST remediations. Further, it is assumed that, based upon past NJDOT experience and the literature the contaminants found at these UST sites are those associated with petroleum products. Listed below are common chemicals of concern for these products as well as NJDEP guidance for cleanup levels (impact to groundwater).

Chemical of Concern	Cleanup Standard Guidance (ppm)	Source
Total Petroleum Hydrocarbon (THPC)	10,000	Petroleum products
Benzene	1	Unleaded gas, kerosene
Toluene	500	Unleaded gas, kerosene
Ethyl benzene	100	Unleaded gas, kerosene
Xylene	10	Unleaded gas, kerosene
PNAs (selected)		
benzo (a)pyrene	100	Kerosene, diesel fuel,
pyrene	100	Light fuel oil
Naphthalene	100	
Chrysene	500	

A similar analysis was conducted for the NJGSA UST program. We believe that there are approximately 1300 USTs that will require investigation and where appropriate remedial action. Based upon an assumption that 50 percent of these tanks over the next five years, will be found as leakers, there will be 650 USTs requiring remediation. Using the 200 CY/UST factor, there will be approximately 130,000 CY of petroleum contaminated soil that may require treatment. (**Figure 4** page 13) provides the location by county of NJGSA tanks known to be leaking. Therefore, the estimated quantity of contaminated soil resulting, over the next five years, from the NJDOT and NJGSA program is 170,000 CY. (**Figure 5** page 14) provides the estimated distribution of the total amount of known soil that need treatment by county from NJDOT and NJGSA USTs.

- Task 2: Identification of Potential Facilities

As noted earlier, several siting criteria are suggested for identification of potential facilities for a centralized land treatment or low temperature thermal desorption unit: location in relation to sources of the contaminated soil; adequate space; suitable environmental considerations; access; available utilities; anticipated regulatory and community acceptance; and potential for reuse of the treated material. Sites considered were NJDOT maintenance facilities and NJGSA managed facilities.

The use of NJDOT facilities are considered a lower priority focus for land treatment because NJDOT maintenance facilities may not have sufficient space. NJDOT facilities may be suitable for transportable semi-permanent or permanent LTTD operations. The use of NJGSA facilities, on the other hand, may be a more suitable approach for land treatment: the distribution of NJGSA USTs that will generate the contaminated soil can support the strategic siting of a centralized facility; sufficient space can be expected at a site of interest; and regulatory acceptance may be facilitated because of the state wide priority set for the NJGSA program. Also, the use of an NJGSA facility can provide opportunities for recycling and the cost saving use of state manpower such as maintenance personnel or prison workforce.

Figure 6 (page 15) divides the state into two sections, northern and southern. This was done to minimize transportation costs in treating the soil. Due to the limited open space in the northern part of the state the use of LTTD was looked at as both an on site and off site clean up/ recycling technology. A facility such as Mt. Hope Recycling can handle loads as large as 1000 cy per day. Mt. Hope is also NJDEP certified to test samples for a list of metals, VOC's, & PCB's to ensure the soil meets NJDEP standards. A similar facility was located in southern N.J. (Walter R. Earle) but was not considered due to its location in the Pine Barrens. The Pine Lands Preservation Act does not allow the transport of contaminated soil from outside to inside the Pine Barrens for treatment or disposal. Therefore, five NJDOT facilities were looked at in the Northern half of the state and three GSA facilities in the southern half of the state.

The following NJDOT sites were looked at for placement of a transportable LTTD Unit:

North Region Electrical Division, Byram
North Region Maintenance Facility, Netcong
North Region Maintenance Facility, Hanover
North Region Maintenance Facility, Rockaway TWP
Central Region Maintenance Facility, New Brunswick

Two sites were chosen for the possible storage of soil and/or placement of a transportable LTTD Unit: Hanover and Netcong Maintenance Facilities. The reasons for choosing these sites are their close proximity to major highways and their remote location with respect to public access. **Figure 7a** (page 16) shows an aerial view of The Hanover Site and **Figure 7b** (page 16) shows an aerial view of the Netcong Site.

The following NJGSA Sites were looked at for land treatment:

- Leesburg Southern State Prison, Leesburg
- Woodbine Development Center, Woodbine
- Albert Wagner Youth Correction Facility, Bordentown

Of the three NJGSA sites in Southern New Jersey that were looked at for possible land treatment, the Albert Wagner facility was chosen for further examination due to it's location and high percentage of clayey soils. During a visit to the site several pictures were taken showing possible soil treatment locations on the 500-acre property (**Figure 8** page 17). Further examination of the site can be done (Post Project) with NJDOT, GSA, and NJIT in coordination with the site manager.

- Task 3: Conceptual Design

The conceptual design for land treatment and LTTD will consider the following: Treatment system throughput required to support NJDOT highway construction and both the NJDOT and NJGSA UST programs; environmental protection requirements; regulatory requirements and operational optimization. Treatment system throughput to be used for conceptual design purposes will be estimated by equally prorating the estimated quantities of contaminated soil over a five year period; e.g. 170,000 CY over five (5) years yields 34,000 CY per year.

Land Treatment Requirements- regulations for land treatment operation provide the following guidelines:

- A 2,000 foot buffer zone on all sides (N.J.A.C. 7:26G-14.7);
- Structural stability of new major commercial hazardous waste facilities (N.J.A.C. 7:26G-14.8);
- Protection of surface water(N.J.A.C. 7:26-14.9)
- Protection of environmentally sensitive areas(N.J.A.C. 7:26-14.10);
- Protection of air quality(N.J.A.C. 7:26G-14.13);
- Construct/operate permits

  (a) Approximately 120 acres of land will be required to set up and operate the treatment cell. This requirement is based upon four major factors: 1) the assumption that two facilities will be constructed to handle the estimated waste generation (e.g. 17000 cy/year); 2) feed rate is about one acre per 1000 cy; 3) a 2000 foot buffer is required; and 4) holding ponds for run off collection and space for equipment storage is necessary (**Figure 9**, page 18).
  (b) Topography of the site should be flat or nearly flat.
  (c) Soil characteristics including sufficient clay to retard downward migration is desired.
  (d) Access should be controlled and adequate for large vehicles.

Low Temperature Thermal Desorption Requirements- regulations provided by NJDEP for LTTD operation provide the following guidelines:

- Mobile unit requires between 5000 Min-10,000 sq.ft. open area
- Protection of environmentally sensitive areas (N.J.A.C. 7:26-14.10);
- Protection of air quality (N.J.A.C. 7:26G-14.13);
- Construct/operate permits

- Task 4: Determining Cost

The cost to the DOT for each technologies listed below is on a per ton basis. **(Table 1)**. This rate was developed by taking all available data on mobile/permanent LTTD, land treatment and direct disposal and, comparing this information with the amounts of soil to be treated at different locations around the state. Direct disposal costs vary with the location in the state and who the contractor is. The cost of an LTTD unit is based on 40 cubic yards per day on site. The cost also varies with the moisture content and type of soil to be treated. It does not, however, include the cost of trucking from other sites to meet the daily requirement. Land treatment is the most economical technology in this case because of the ability to use state land and the use of labor from the state correctional facilities.

The costs for dealing with the contaminated soil by alternative means are included in **Table 1**. These numbers are based on the total quantity of contaminated soil in the state. **Table 2** shows the costs for the recommended technologies in the northern and southern part of the state.

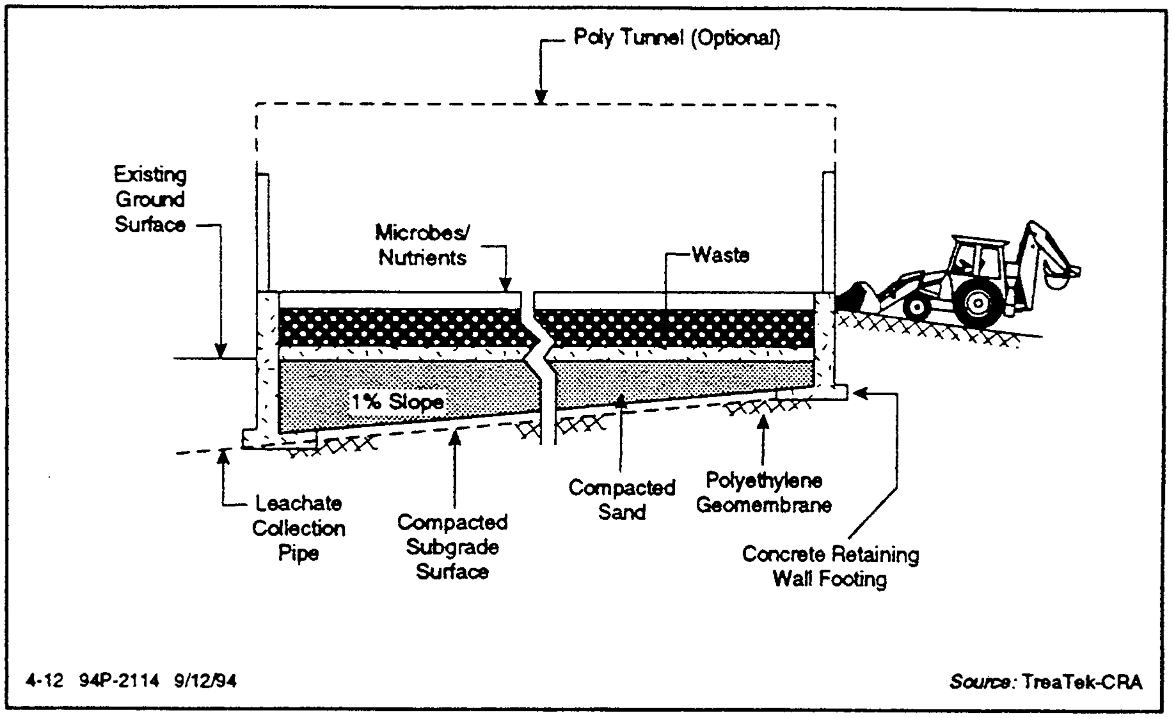
TABLE 1

Technology	Amount of Soil to be treated (tons)	Cost per cubic yards (cy) (dollar)	Total cost (millions of dollars)
Direct disposal	170,000	$60-$120	$10.2-20.4
LTTD(on site) thermal desorption	170,000	$40-$70	$6.8-11.9
LTTD(off site soil recycling facility, 22 ton, min. trucking included)	170,000	$32-$36.50	$5.4-6.2
Land Treatment off-site	170,000	$40-$50	$6.8-8.5
Land Treatment (using state land and prison inmates)	170,000	$10-$20	$1.7-3.4

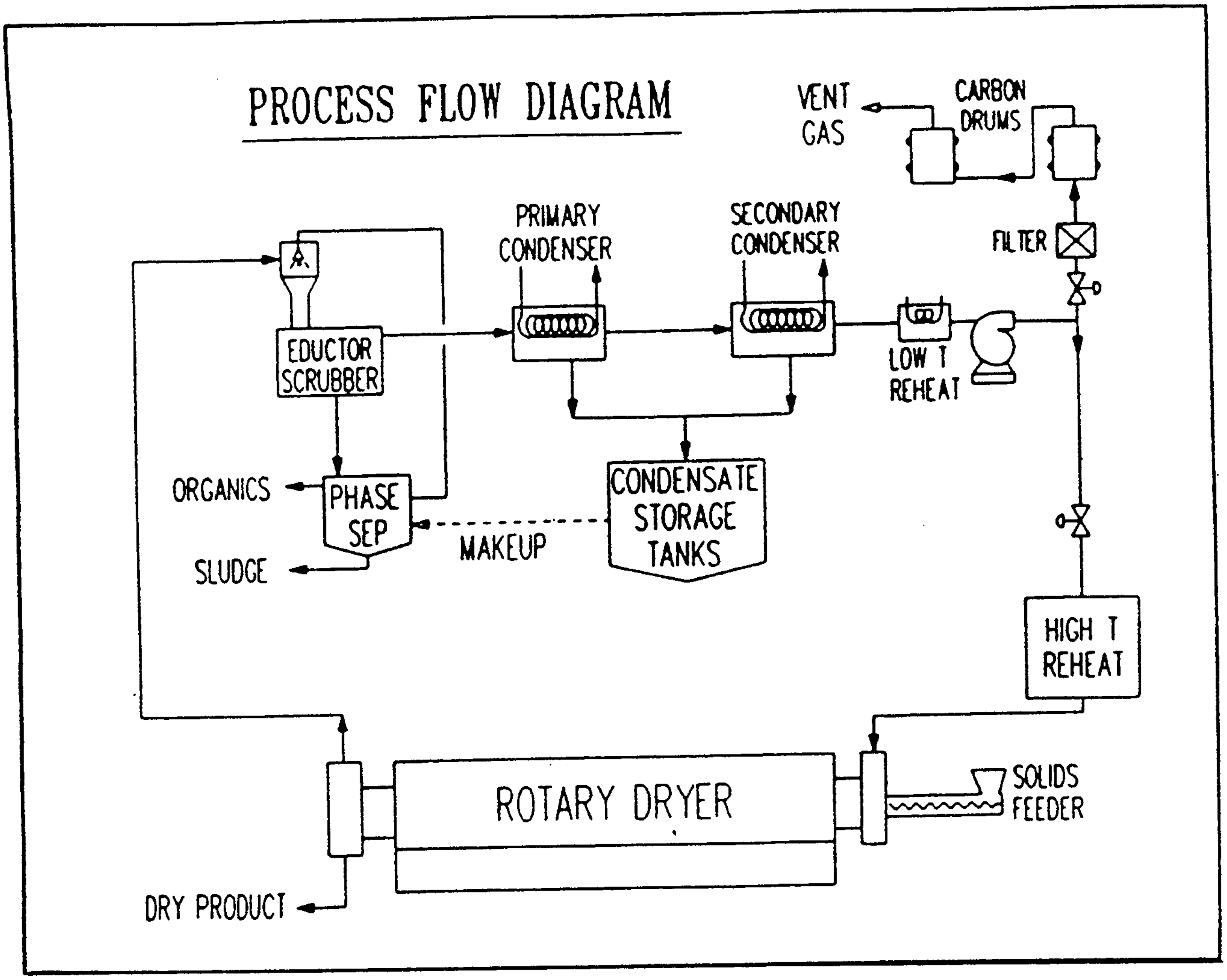
TABLE 2

Technology	Amount of Soil to be treated (tons)	Cost per cubic yards (cy) (dollar)	Total cost (millions of dollars)
Northern NJ LTTD	42,000	$32-36.50	$1.3-1.5
Southern NJ Land Treatment (using state land)	128,000	$10-20	$1.3-2.6

NOTE: Quantities are estimates based on data provided by NJDOT and NJGSA.
The costs are based on soil estimates and will vary with amount of soil to be treated.



Typical Land Treatment Layout
Figure 1



Low Temperature Thermal Desorption
Unit Configuration
Figure 2

Tanks owned by NJDOT

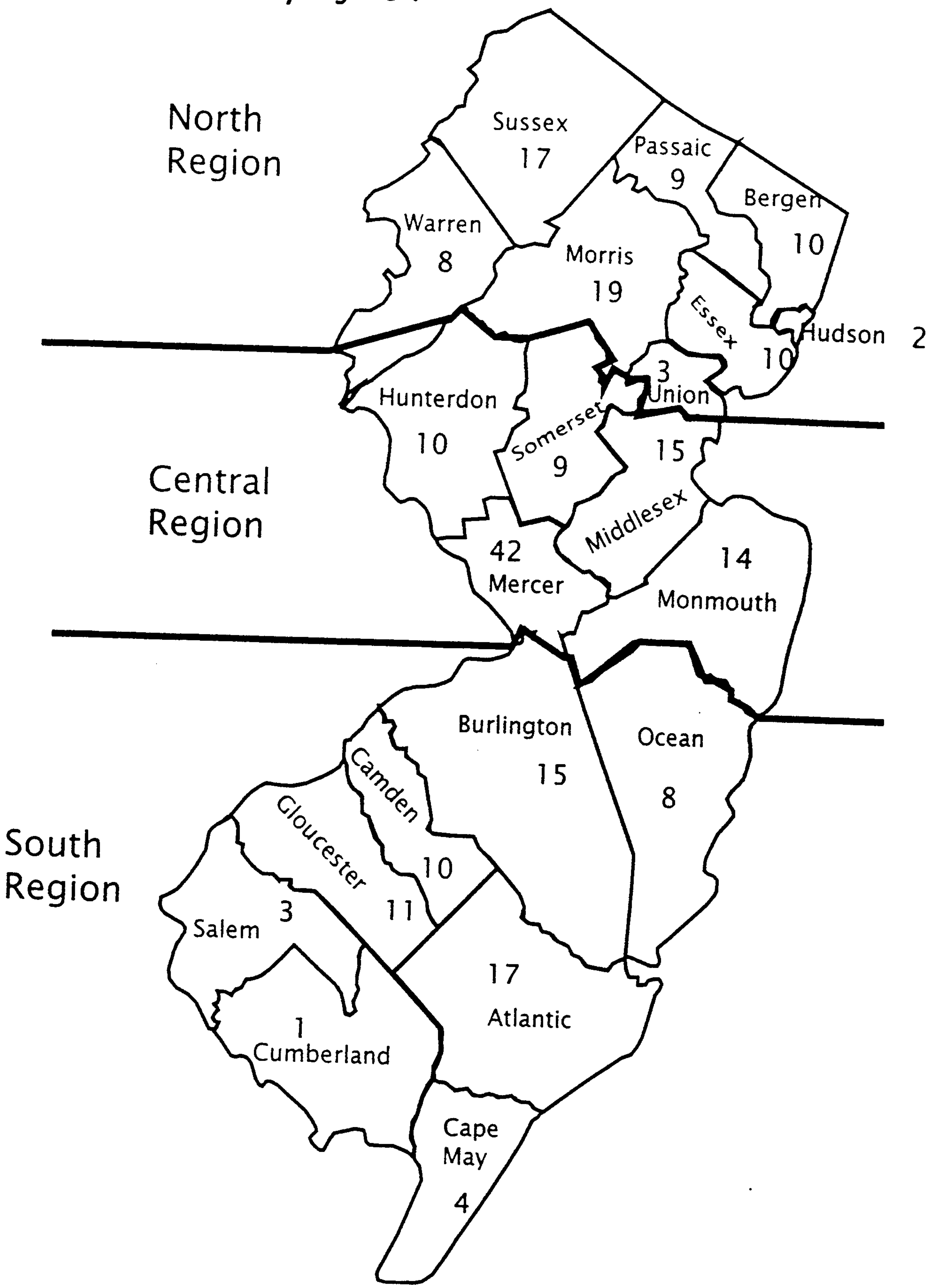


Figure 3

Tank owned by GSA

is the number of
known leaking tanks
in that county.

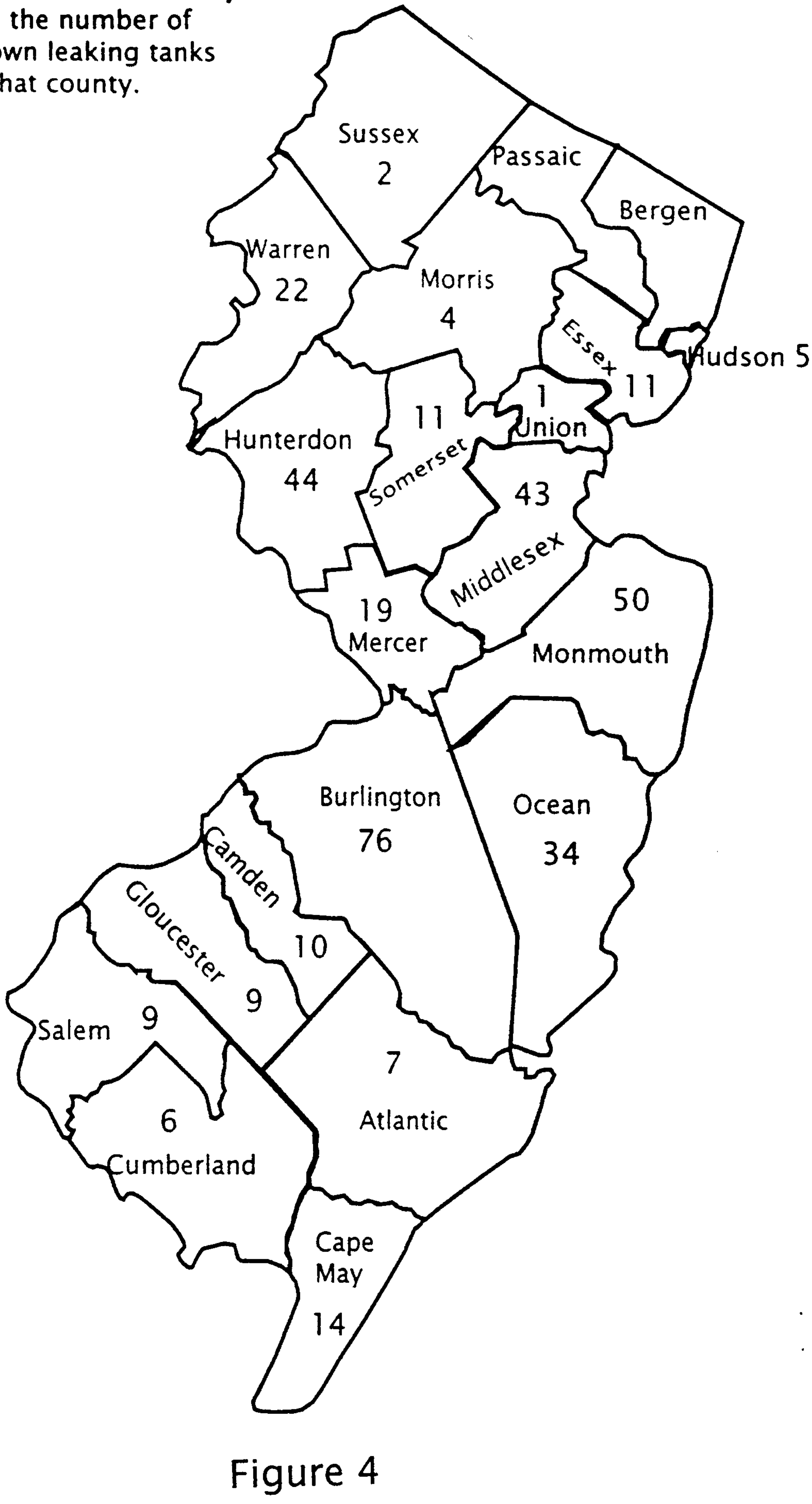


Figure 4

Total amount of
known soil that
needs to be treated.
\# x 1000 = CY of soil

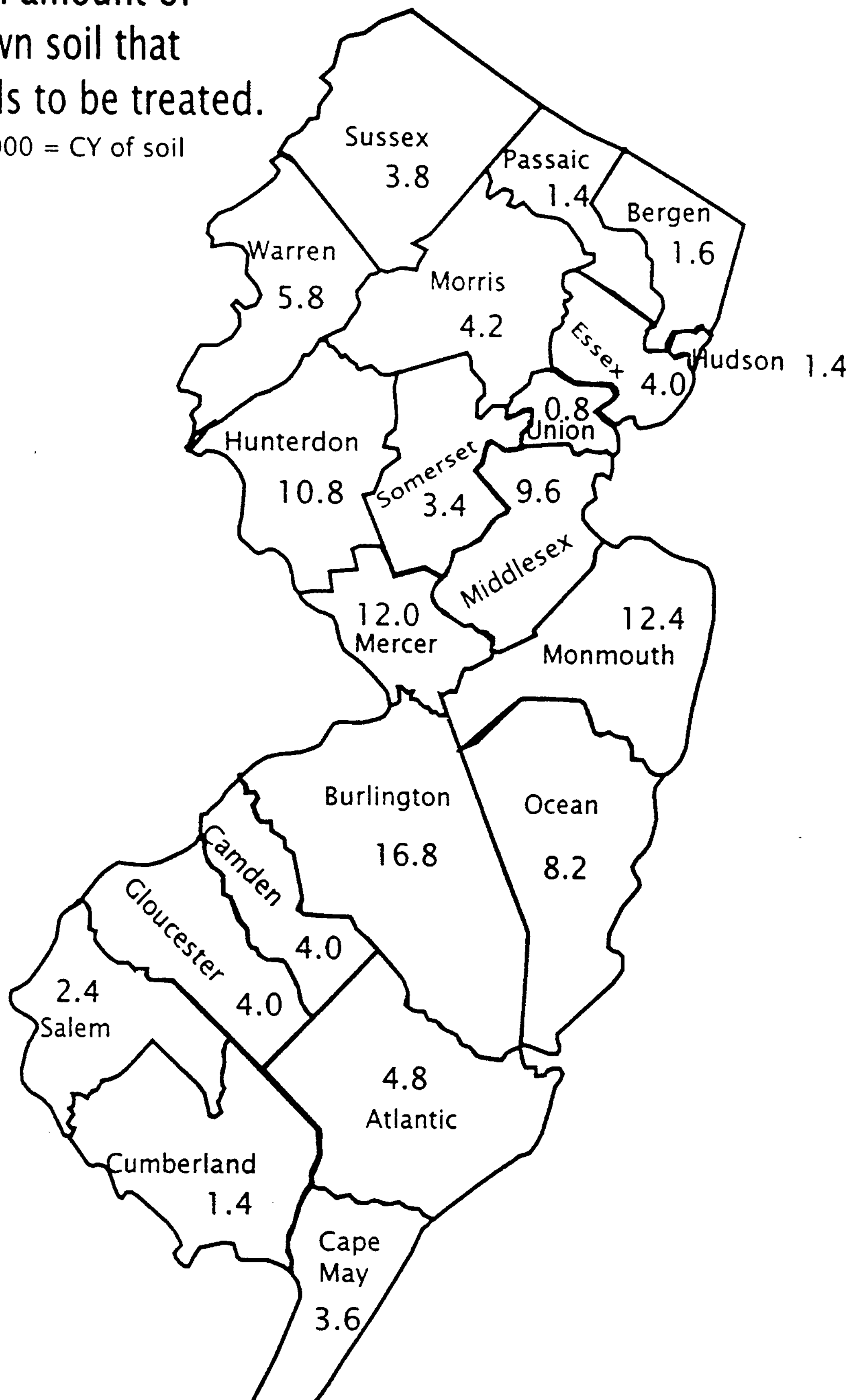


Figure 5

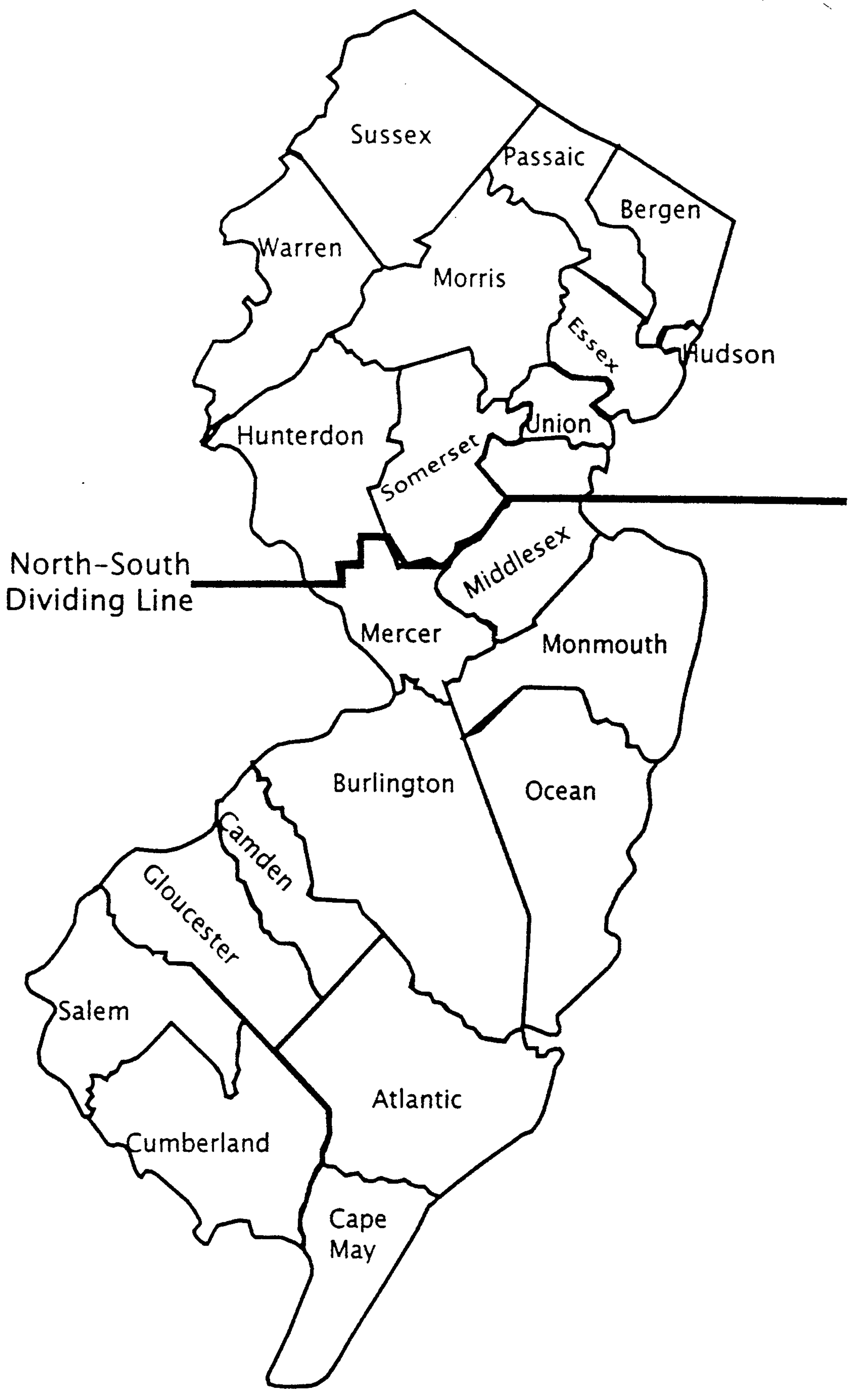

Sussex
Passaic
Bergen
Warren
Morris
Essex
Hudson
Hunterdon
Somerset
Union
North-South
Dividing Line
Middlesex
Mercer
Monmouth
Burlington
Ocean
Camden
Gloucester
Salem
Atlantic
Cumberland
Cape
May

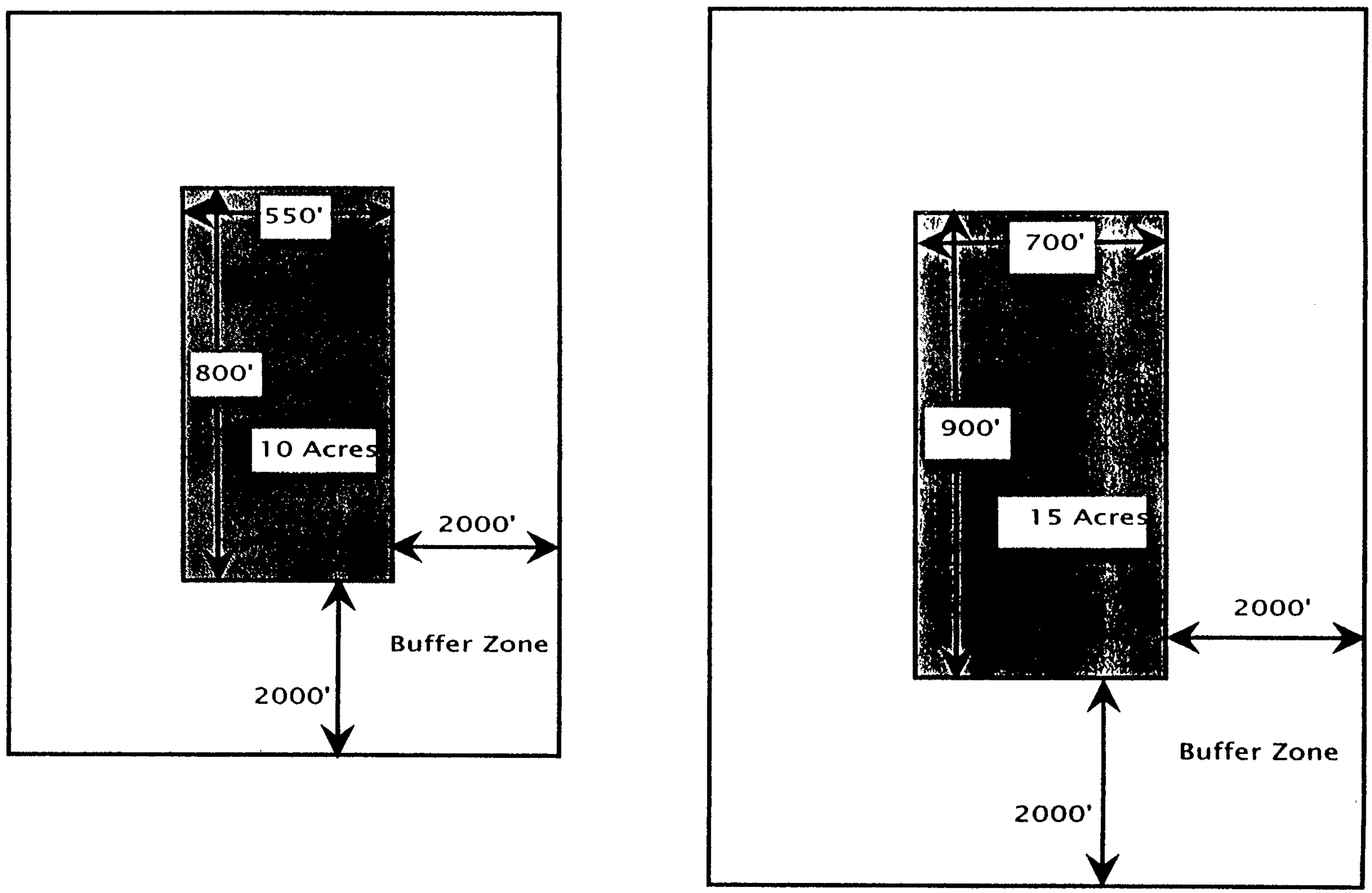
Figure 6

Figure 7(a): Aerial View of Hanover Facility

Figure 7(b): Aerial View of Netcong Facility

Figure 8(a): Albert Wagner Facility

Figure 8(b): Albert Wagner Facility



Typical Southern Jersey
Land Treatment Cells

Figure 9

N.T.S.